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APPLICATION FOR UNITED STATES PATENT

For an invention titled

BATTERY MANAGEMENT SYSTEM AND APPARATUS

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## BACKGROUND OF THE INVENTION

The invention relates to the management of large stationary batteries. The invention is a comprehensive system and apparatus for the management of stationary batteries that are used for backup power and are deployed in widely dispersed locations. The OMS<sup>TM</sup> (Optimization Management System) solution is comprised of battery tags (sometimes referred to herein as “Mega-Tags,” which are preferably serialized bar-coded identification labels), a battery testing and data acquisition device, and the OMS<sup>TM</sup> web-based software. These components work together to provide a platform for managing a large number of perishable, expensive, and geographically dispersed assets.

The invention solves many of the unique problems associated with batteries. Batteries are perishable. That is, they have a limited shelf-life and a limited useful life. Stationary industrial batteries of the type that benefit from the OMS<sup>TM</sup> solution are typically sealed lead-acid batteries. These electromechanical devices typically must be installed within 6-10 months from date of manufacture or else they need to be recharged. In addition, most of these batteries are designed for a 10 year useful life, but in the field generally last only from 2-6 years. The discrepancy between design life and actual life is a major problem for users of these batteries.

Stationary batteries are also large, heavy and expensive. They are generally used in large numbers to provide the required backup power. Keeping track of these devices therefore provides an additional asset management challenge.

Batteries contain hazardous substances which are toxic to the environment. There are strict rules and regulations governing the disposal of batteries. These rules and regulations also contain documentation requirements. Users must be able to provide adequate proof of

compliance or face severe penalties. Documentation is a highly manual, expensive process, and most compliance is done as an afterthought.

Batteries are generally deployed in strings of two or four 12-volt units or in strings of six or twelve 2-volt units, in order to power 24 volt or 48 volt equipment. This electrical

5 combination of batteries compounds the difficulty of managing these storage devices. In sum, managing stationary batteries is difficult, and is generally not a core competency of most businesses that use these batteries.

## BRIEF SUMMARY OF THE INVENTION

The OMS<sup>TM</sup> (Optimization Management System) tracks batteries from cradle-to-grave. It enables companies with large deployments of stationary batteries to manage assets that are both perishable and geographically dispersed, and therefore difficult to manage.

5 OMS<sup>TM</sup> is comprised of the following items which work together to provide this unique service: First, Mega-Tags (preferably serialized bar-coded identification labels) are affixed to every individual battery. A battery testing device (preferably the BatteryCorp BC-T2000 or similar testing device), which contains both a bar code reader and a serial port to connect to a PC, scans a Mega-Tag and then performs its test on any given battery. Batteries are usually deployed in  
10 “strings” of electrically interconnected units to increase voltage and output power. Each battery test data point is stored along with the unique identifier value associated with the individual battery unit. The user connects the BatteryCorp BC-T2000 (or similar testing device) to the serial port of a PC with the provided null-modem cable. Linking software (preferably the T2000 Link software) facilitates the transfer of data from the testing and data acquisition device to the  
15 PC internal storage. The user then logs into the proprietary website and clicks on the Upload Data icon; the T2000 Link software uploads the specified data file to a proprietary web server. The web server processes the data file, storing the pertinent data in the appropriate tables of the OMS<sup>TM</sup> database.

The invention provides comprehensive reporting and analysis options. This includes both  
20 operational and financial reports, as well as detailed recycling documentation. The OMS<sup>TM</sup> auto-notification feature emails reminders to customer technicians that testing is required. These emails are based upon customer-defined business rules. (Testing time period interval and escalation procedure, by business unit.)

The OMS<sup>TM</sup> solution enables users of stationary batteries to manage all aspects of their battery deployments. It is the only available tool that automates the process of uniquely  
5 identifying, testing, evaluating and reporting on the state of health of any given battery. It provides information on installation, deployment, testing, recycling and destruction. It provides information in both aggregate and detail formats, for both internal and external use.

Its advantages are many. It enables users to manage large, widely dispersed deployments of stationary batteries in an efficient and cost effective manner. It increases the reliability of the  
10 backup power plant, because the operator now has information on the performance status of the batteries. The system also facilitates the safe recycling of potentially toxic devices, while reducing the risk of non-compliance with governmental regulations.

Another object of the invention is to provide a battery management system easily applied to existing batteries without modification of the batteries, and that easily accommodates a varied  
15 inventory of batteries from different manufacturers.

Other objects and advantages will be more fully apparent from the following disclosure and appended claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and objects of this invention and the manner of obtaining them will become apparent and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction  
5 with the accompanying drawings, wherein:

FIG. 1 is a representation of a tag for use with the present invention;

FIG. 2 is a perspective view of a battery unit with a tag associated with the battery;

FIG. 3 is a view of a battery testing and data acquisition device for use with the present invention;

10 FIG. 4 is a flow diagram illustrating the process of the present invention.

## DETAILED DESCRIPTION

The invention provides and coordinates battery testing, maintenance, installation, fulfillment and disposal of batteries, and is capable of performing these functions over a wide geographical area. It seamlessly integrates these services via the BatteryCorp BC-T2000 tester and the OMS<sup>TM</sup> web based platform. This innovative solution helps companies improve their backup power systems while reducing costs.

Fig. 1 shows a preferred Mega-Tag to be associated with an individual battery. The tag is associated with a particular battery unit, so that the unique identification number embedded in the tag is consistently associated with that particular battery. Preferably to assure such continued association, the Mega-Tag is affixed to the exterior casing of the battery (5) with an adhesive, as shown in Fig. 2.

Mega-Tags are preferably bar coded labels that contain a unique identifier for the associated battery. The tag shown in Fig. 1 has, preferably, the following information: (1) the service provider name and telephone number; (2) the bar code of a unique identification number; (3) the battery model; and (d) the unique identification number in human readable form.

Because of the preferred inclusion of human readable information in conjunction with the bar code identification number, the Mega-Tag is preferably affixed where it can be viewed and scanned by a human operator without dislocating the battery.

Fig. 3 shows a testing and data acquisition device for use with the present system. The device shown is a BatteryCorp BC-T2000 device. However, different testers could be used, but such testers should be able to import data from a bar code reader, and have the ability to export data files. The bar code scanner or reader is preferably in direct communication with the battery testing device for ease of use and reliable interface. This is preferably accomplished by use of a

port (6) for a bar code reader and for connection to a computer. Also shown in Fig. 3 are ports for two testing probes (7), and A/C current in port (8) and an on/off switch (9). The data files can be in a number of formats, since the invention is a flexible platform with the ability to interface with data files in a number of formats.

5 In particular, the battery tester should be able to store test results in memory, associating each test with the pertinent unique scanned identifier. The tester also should be able to output the test results in an industry-standard file format, such as ASCII text or Excel XLS. The tester should be able to perform impedance or conductance testing (IEEE approved technologies). Many companies that utilize stationary batteries perform impedance or conductance tests.

10 In an alternative embodiment, the tester may operate with an infra-red thermometer, either integrated with the battery tester or otherwise in communication with the tester. The thermometer would read the temperatures of individual batteries, and the temperature associated with the unique identifier for that particular unit. Such a thermometer would provide additional information concerning the subject battery unit that would be read, uploaded and stored. Such a  
15 thermometer would obviate the need for a separate thermometer to record ambient temperature surrounding the battery units, which is stored along with the battery test data, and provide a more accurate reading of individual unit temperatures.

The testing device files preferably have the following header information. First, a Location Code is included with the file. This is a code that links the database of the invention,  
20 indicating the location of the battery. It is only required for new deployments, so that the system will associate the data with the pertinent location. Second, the ambient temperature is stored along with the test information, because battery temperature is correlated with life expectancy. This information is also required by many battery manufacturers for warranty claims.



The testing device files preferably have the following detail information. First, there is a Unique Identifier that identifies the individual battery unit. Second, the date and time of the test are included in the file. Third, the test value, which is the individual battery unit test result, typically either an impedance value or a conductance value. It is the key indicator of the battery's health. The greater the impedance or the lower the conductance (they are inverse measurements of the same attribute) the poorer the state of health of the battery. Fourth, a strap test value, which is optional. Strap testing is a test of the interconnection between the current battery itself and the next battery in sequence (in the string). Fifth, a voltage is included, which is the voltage measurement of the battery. Voltage is another indicator for battery health and is also an indicator of the status of the device which is used to charge the battery.

Database management is another component of the present invention. Each battery test data point is stored along with the unique identifier value associated with the individual battery unit. This enables trend analysis reporting and individual battery detail reporting.

In operation, the user connects the battery testing device to the serial port of a PC with a null-modem cable, a standard computer peripheral device which is readily available. The linking software facilitates the transfer of data from the testing and data acquisition device to the PC internal storage. Typically, the user clicks the "Transfer" button displayed on the graphical user interface (GUI) of the software. The response will be "Waiting for data." Prompts on the battery tester will guide the user to the menu option for downloading the data.

The user then logs in to the proprietary service provider website. The user will then click on the Upload Data icon displayed within the GUI. The linking software then uploads the specified data file to a proprietary web server. The web server processes the data file, storing the pertinent data in the appropriate tables of the OMS<sup>TM</sup> database.

Data elements stored include:

- a. Unique ID
- b. ID of the user who performed the test
- c. Test date and time
- 5 d. Test type (Impedance or Conductance)
- e. Test measurement value
- f. Strap measurement value if applicable
- g. Voltage
- h. Ambient temperature

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The invention then generates comprehensive reporting and analysis, including preferably the following:

- a. Battery Test History (detail by location)
- b. Battery Test Summary (overview of tests and results)
- 15 c. Untested Batteries (verification tool)
- d. Battery Installation Aging (based upon installation date)
- e. Performance Status Report (analysis which groups batteries based upon user-defined status criteria for “pass”, “fair”, “warning” and “fail”)
- f. Replacement Forecast (analysis based upon user-defined criteria to estimate
- 20 costs of upcoming replacements)

Auto-notification is another part of the present invention. This feature is based upon customer-defined business rules. These rules typically test interval and escalation procedure, automatic battery replacement intervals and escalation procedures. These business rules can be

specified by customer-defined business units. This provides considerable flexibility for the user in how to utilize the automated notification process. All notifications are preferably made via email or other electronic transmission means.

Fig. 4 provides a high-level overview of the process of the present invention. The OMS<sup>TM</sup> software will send an automated email notification to the pertinent technician that various locations require battery testing. This process is called Auto Notification. The person that is informed of the required testing can be either an internal (i.e. employee of the customer company) or an outsourced (third party) technician. This Auto Notification feature is not required for functioning of the present invention, since users may utilize the OMS<sup>TM</sup> software with this feature disabled, and set up their testing schedule separately.

The technician tests the batteries with the batter tester and uploads the data via a network connection, preferably a global computer network such as the Internet, to the OMS<sup>TM</sup> proprietary database, preferably located on a server. Upon receipt of uploaded data files, the OMS<sup>TM</sup> software immediately processes the data and sends an automated report (Auto Report) back to the technician. The report will indicate whether the batteries all “Passed,” or if any “Failed” the test. The report may also provide instructions to the technician on whether or not to replace any given battery or all batteries, depending upon the business rules for that customer (Auto Replacement). If Auto Replacement is enabled, the OMS<sup>TM</sup> software will route the appropriate information to the pertinent installation technician. The OMS<sup>TM</sup> software may provide recycling documentation, so that batteries being replaced may be properly recycled.

An Auto Report is generated via the battery tester and sent via a network connection, preferably through a global computer network such as the Internet, to the OMS proprietary software and to the OMS database.

The OMS<sup>TM</sup> software platform has been built using programming tools from Microsoft.

The integrated development environment (IDE) includes productivity boosting features such as automated syntax management, a powerful editor, line-by-line debugging, graphical design tools (including visual classes and subclasses), and integrated database access. The platform is fully object-oriented, offering developers the benefits of full inheritance, encapsulation and polymorphism. This dramatically reduces design, coding, and testing times, producing a highly efficient rapid application development (RAD) environment.

The methodology employed in the OMS<sup>TM</sup> platform can be referred to as business function modeling (BFM). The entire orientation of the development effort revolves around the business rules and processes. This may also be referred to as an object functional model. Each function encapsulates a particular business task, yet from a development point of view it also inherits any and all system functions necessary to perform the intended task.) For example, a purchase order object would accept the request, access the necessary data, employ all pertinent business rules, validate the posted data, update the database, and generate a response - all within a single software object. This is a major architectural advantage.

Finally, the OMS<sup>TM</sup> platform contains a rich set of connectivity tools. It can easily import/export data in various formats, from plain text to delimited files to Excel to XML. In fact, the battery tester upload module accepts data in both text and XLS formats. OMS<sup>TM</sup> can also directly access any ODBC compliant data source, such as Oracle, DB2 and other databases. However, we expect that the XML classes in particular will facilitate seamless communication between OMS<sup>TM</sup> and any related systems.

The specific products utilized to build OMS<sup>TM</sup>

- Microsoft Visual FoxPro 7.0 (IDE)
- West Wind Web Connection (Base classes for web services)
- Macromedia HomeSite (HTML/JavaScript editor; any can be used)

- IDAutomation.com bar code fonts
- Adobe Acrobat 5.0

Web Connect by West Wind Technologies is a framework of base classes for building web  
5 applications. These classes perform all low-level functions for authentication, request  
management, session management, data formatting and output.

Since other modifications or changes will be apparent to those skilled in the art, there  
have been described above the principles of this invention in connection with specific apparatus,  
it is to be clearly understood that this description is made only by way of example and not as a  
10 limitation to the scope of the invention.

What is claimed is: